On Digestion.

Passed March 7th 18 at 8 P.M.

Passed March 7th 1832 - at 8 o'clock

In the following pages, I propose to offer a few remarks on the subject of Digestion; or the process, by which the food is converted into matter adapted to supply the wants of the animal system.

It will not here be necessary to enter into any detail with respect to the Anatomy of the organs concerned in this all important function; but I shall very briefly notice some of the most important points.

A long tube, consisting of several different layers or tunics, commences at the mouth, & forming numerous convolutions, so as to fill (with sundry other organs) the space between the spine posteriorly, & the abdominal muscles in front, & varying in length from twenty eight to thirty five feet in different individuals, constitutes a very important portion of the digestive apparatus. This tube receives the ~~excretory~~ the excretory ducts of the liver & other glands; & affords a passage for the excrementitial matter to pass through, in order to be discharged at its lower extremity, termed the anus.

Before entering the stomach, the food has to undergo some important changes, which I shall now proceed to mention.

In many, the food torn & minutely divided by teeth is mixed with a quantity of Saliva, which is now poured forth in abundance from the excited glands, & from the secretions of the numerous follicles of the mouth.

It is next, by the action of the tongue, & of some of the muscles of the mouth, forced into the upper portion of the Pharynx; & acting as a foreign substance, invites the contraction of the muscular bands, by which it is surrounded, which contracting speedily expel it into the Œsophagus.

The muscles of the Œsophagus contract in a similar manner, & the food is discharged into the cavity of the stomach, there to undergo changes, which for centuries have at once deeply interested & ~~astonished~~ surprized physiologists.

The importance of the preceding process of mastication has long been known. Many of the victims of dyspepsia can trace the origin of their disease, to the circumstance of their neglecting to submit their food, for a sufficient length of time, to the action of the teeth & saliva. It is also a well known fact, that many persons, who unfortunately have lost their teeth, & those in whom the supply of saliva is deficient, do not enjoy good health, but these defects being remedied, they speedily regain their former vigour.

With respect to the saliva, it may be stated, that it is colourless, tasteless, & is rather heavier than water - The celebrated Pringle was one of the first to assert that it was possessed of decided antiseptic properties -

Professors Tiedeman & Gmelin state that saliva contains - Mucus, the proper salivary matter, Osmazome, & in some instances, a small quantity of albumen, with a little fatty matter containing phosphorus &c - It increases the sense of taste, & by mixing with the food after it has been minutely divided by the teeth, converts it into a softened mass, fit to enter the stomach -

Such, in Man & the non ruminating animals, is the process by which the food is prepared to undergo in the stomach the important change of Chymification; but the same end, which is thus attained by the above mentioned process in man &c, is provided for in other animals, by various contrivances not less curious and interesting -

In the ruminating animals, the food being only partially torn by the teeth, softened by the saliva, passes into the first & second stomachs, in which it remains for some time, & after being mixed with the fluids exuding from the interior of those parts, is regurgitated into the mouth, for the purpose of undergoing more fully the operation of Mastication - When sufficiently softened, it is allowed

to pass into the third stomach, from which in due time it is propelled into the fourth –

In granivorous birds, the food first passes into the Crop, & after being mixed with the fluid there secreted, enters the stomach. On examining the stomach of one of these birds, every beholder must remark with a high degree of interest the evidence of great strength & durability – Spallanzani found that metallic tubes were fractured, & glass ones crushed by the action of this powerful muscular apparatus –

The extent to which he carried his experiments without injuring the stomach, at a first view appears almost incredible; for in one instance, he made a Turkey Cock swallow a leaden ball armed with a dozen needles; & found on examination, that notwithstanding the needles were separated from the ball, & crushed into numerous pieces, & the ball itself bore evident marks of contusion, the stomach did not appear to have received the slightest injury – On performing a similar experiment with a ball, to which he had attached several small lancets, he found that although the lancets were broken, the stomach remained uninjured –

In his experiments, he observed very generally a number of small stones in the stomachs of these birds; & he supposed that digestion was assisted by their mechanical action –

Chymification. — If after allowing the food to remain for a sufficient length of time, we open the stomach of any animal, we shall find it converted into a pulpy & viscid mass, of a greyish colour, & of a rather a sweetish taste: this substance is denominated chyme, & is found in most abundance at the pylaric extremity of the stomach —

I must next consider what is the agent of this important change. It may readily be supposed that a subject offering so much room for hypothesis, early received the attention of physiologists, & such on examination we find to be the fact. Theories have been invented, & maintained with all the eloquence of genius & talent, they have for a time appeared well calculated to account for each phenomenon; but each in its turn has been overwhelmed by facts & arguments, brought forward to support some other hypothesis, destined in a short time to endure a similar fate —

Some of these theories it will be proper here to notice in a very brief manner, inasmuch as most of them have long since been consigned to oblivion; & for the arguments by which they have been refuted, I must refer to the various works on the subject —

The most ancient theory of digestion is that advanced by Hippocrates, which attributes it to

a species of Coction - This opinion owing to the veneration in which the doctrines of that great man were held, once ranked amongst its advocates many distinguished men, but has long since been abandoned

Digestion was also supposed by some, to be owing to a species of putrefaction; but ~~this has been shown to be incorrect~~ fallacy of this opinion has been demonstrated by experiments, which prove that putrefaction would be vigorously resisted by the vital powers of the Stomach -

Other Physiologists have attributed digestion to the effects of trituration, but the impossibility of this supposition being correct is at once perceived, if we carefully consider the nature and structure of the human stomach - The degree of force, to which some of the advocates of this theory would (subject) give the stomach, bears on its face the stamp of absurd exaggeration.

Others, again, have supposed that a species of fermentation was the agent, by means of which the process was effected: this opinion was most warmly supported by the celebrated Van Helmot, who was probably the original suggester of it -

Much diversity of opinion however existed, as respects the kind of fermentation to which we should attribute it, some of its advocates believing that it most resembled the putrefactive, others, the vinous, & some, the acetous - Yet, although some attempts have been made within more modern times to reestablish this theory, it has not, at present, many supporters -

It has long since been proved by experiment, that the fluids of the stomach have a great tendency to resist, or at any rate, to impede the occurrence of fermentation.

The above mentioned theories having almost universally been consigned to oblivion, most physiologists of the present age have attributed the conversion of food into chyme to the action of a fluid poured into the stomach, & which has received the title of Gastric Juice -

To support & prove the correctness of this opinion, the illustrious Spallanzani devoted much of his time & attention, & instituted a lengthened series of experiments, which have deservedly immortalized his name - These experiments clearly show, that the only object of his search was truth; & the reader is at a loss, whether he should most admire the candour & modesty, which are evident throughout his work, or the great ingenuity and industry with which he prosecuted his enquiries - He supposed digestion was effected by means of a fluid, possessed of strong dissolving powers, which he believed, collected in the stomach, when it was empty, & which as before mentioned has been termed the Gastric Juice - He believed that this fluid varied in different animals, But that it was of nearly if not exactly the same nature in the same species of animals at all times; thus he supposed that the gastric juice of carnivorous animals would dissolve flesh,

but would not act on the food taken by granivorous ones and vice versa. He believed that in some animals this fluid proceeded from the oesophagus, in others, from the stomach, & in others, again, probably from both of these sources.

In order to obtain it, he forced different animals to fast for some hours, & then killing them, he carefully extracted the fluid. In other instances, he enclosed small pieces of dry sponge in tubes, pierced with holes so as to freely admit the fluid, & having caused different animals to swallow them, allowed them to remain till they were filled with it; he then easily obtained the fluid by extracting the sponges.

He found the juice thus obtained, frothy, viscid, colourless, & possessed of little if any taste; after remaining for some time in a glass vessel, it deposited some sediment.

Much diversity of opinion has always existed with respect to the nature of the gastric fluid; Spallanzani supposed from his experiments that it was neither acid nor alkaline.

Scopoli on analyzing this fluid taken from a cow, discovered water, gelatin, phosphate of lime, & Muriate of Ammonia.

Subsequent experiments made on the fluid obtained from ruminating animals, have detected, besides those substances, albumen & phosphoric acid.

Tiedemann & Gmelin state that they have detected the presence

of an acid in the gastric juice of the cat, dog, rabbit, & horse. Their analysis revealed the presence of the acetic & muriatic acids, & in the fluid obtained from the horse they discovered the existence of the butyric acid.

Spallanzani was next desirous to discover whether this fluid was the active agent of digestion; to ascertain which he performed numerous experiments. Having procured a number of tubes of a suitable size, pierced with holes for the purpose above stated, he introduced into them different articles of food, caused them to be swallowed by different animals, and in due time on examination, he found that the food was converted into chyme. He remarked that this result occurred sooner and to a much greater extent, if he took the precaution of chewing the food previous to introducing it into the tubes, and that the change was most perceptible, when the fluid was very freely admitted through holes of a large size. He subsequently repeated some of these experiments on himself, by means of small wooden tubes; having sufficiently bruised the food, he observed the same precaution as in the former experiments, & on examination he found that a similar result had occurred. At other times, he made use of small linen bags in place of the tubes: the linen remained uninjured, but the food had undergone the expected change.

* Dr Stevens in his inaugural essay, published in Edinburgh in the year 1777, details a series of very interesting experiments, which strongly support this theory -
Having the good fortune to meet with a person, who possessed the faculty of vomiting at pleasure, he caused him to swallow a number of small silver spheres, perforated, for the purpose of freely admitting the gastric fluid, having previously filled them with different articles of food; and found, when the spheres were ejected, after some hours, by vomiting, that their contents had disappeared. - The results as to the effects of the gastric fluid upon food out of the body are ~~similar~~ confirmative of to those related by Spallanzani.

Dr.

On varying the thickness of the bags, he remarked that the change occurred soonest in those which were of a very thin texture, and for a very obvious reason, since in that case, the action of the fluids was much less impeded, than when he made use of linens of a denser texture.

He next desired to discover if it were possible to produce digestion artificially, by immersing food out of the body in the gastric juice. In order to satisfy himself on this point, he placed some food in tubes, partially filled with this fluid; and found that provided he afforded a sufficient degree of heat, and made use of fresh fluid, or that which had not been previously employed in his experiments, the food was converted into chyme.*

This theory, so ably supported by its illustrious inventor & other distinguished men, for a very considerable length of time, was received by nearly the whole body of physiologists; and even at the present day, ranks amongst its advocates, very many distinguished individuals, who have devoted considerable attention to the subject, and who after patient & close investigations, believe it is the most rational method of explaining this highly interesting point.

Yet this opinion lies open to many objections, and science has been assailed, especially within some

years past, by many weighty arguments, calculated at least to moderate the satisfaction, which it formerly so universally gave, supported as it was by the experiments and talent of Spallanzani, Stevens of Edinburgh, John Hunter, & numerous other names—

The celebrated Professor Chaussier of Paris has stated, for some years past, his conviction, that the fluid, to which such powers have been ascribed, is composed of the saliva mixed with the mucus of the stomach.

Mr. De Montegre, who was endowed with the faculty of vomiting at pleasure, made a number of careful experiments on the subject in question; & he asserts with great confidence, that the Gastric juice is composed of mere saliva, a greater or less quantity of which, is turned acid by its residence in the stomach—

She frequently attempted with great care to produce the Artificial digestion, as it was termed by Spallanzani, but he was never able to succeed—

Where we consider the important powers attributed to this fluid by Spallanzani, we should, from common experience, expect that its analysis would reveal some potent agent in its composition, but so far as the present time at least, the greatest

skill of the most distinguished chemists has not revealed the expected secret -

We ought, by attending to the proper precautions, to be able, in our experiments with the gastric juice on food out of the body, to produce what has been termed Artificial digestion, or a change in the food, similar to that which it undergoes in the stomach; & yet we find that persons celebrated for their skill in experimental research, & for their patient investigations of intricate points, have stated that they could not succeeding in effecting this object -

It has long been known, that many of the affections of the mind interfere with the proper performance of the digestive process - Individuals, who have eaten a hearty meal, especially if they be of the nervous temperament, often have the process seriously disordered, on the reception of bad news, sudden misfortunes &c: this fact would rather makes us attribute digestion to something else than the action of a mere chemical agent. The powerful narcotic drugs have a similar power in impairing this process -

If we examine an individual in whom the food is undergoing this important change, we shall find him inclined to sleep, sensible of a feeling of chilliness over the surface of the body, his intellectual powers imp

in some degree of torpor, and other marks of the vital energies of the system being attracted with no inconsiderable degree of force towards the stomach, as a sympathetic point: these circumstances have been brought forward as arguments in favour of the theory which supposes chymification to be owing to the agency of a vital power resident in the stomach, and certainly would seem unnecessary, if it were produced by a chemical action -

The circumstance of some degree of repose being very agreeable after eating, although the hardy inhabitants of the country does not require it equally with the more feeble citizen, militates against the supposition of chemical solution; but the importance of this repose was long since clearly proved by the indefatigable Hunter, who fed two dogs on the same food, at the same time; (he having observed that they were both in good health) one he took on a hunting excursion; the other he allowed to remain at rest; on killing them & examining the contents of their stomachs, he found that the food of the former remained unaltered, whilst that of the latter was converted into healthy chyme -

It is now well known that the surface of the food next to the internal lining of the stomach is first converted into chyme, & that the change gradually goes on to the centre of food, the layers passing off towards the pylorus, leave a new surface to be acted upon;

but this circumstance seems more easily explicable on the supposition that Chymification is due to a vital power, which requires that the food should come in contact with the internal surface of the stomach —

From these considerations, I think that the process of Chymification may, with no little propriety, be attributed to the joint influence of the Gastric juice & a vital power possessed by the stomach, intended to aid very materially in the accomplishment of this important object — Certainly, in the Gastric juice, we have a solvent of considerable importance, although probably some of the supporters of this theory have carried their speculations on its powers to too great an extent; and on the other hand, to attribute the process to the action of this fluid alone, would be going farther than the facts & arguments, brought forward by the opposers of the theory of Chemical Solution, (the most important of which I have mentioned above) would justify — By thus attributing, as has been done by some very respectable writers on the subject, the process to the influence of both these agents, we shall probably come as near the truth, as the present state of our knowledge will allow — With respect to the manner in which this vital power acts on the food, no satisfactory explanation has as yet been given —

Chylification — The food having undergone the proper preparation in the stomach, is forced by the peristaltic movements, which now become vigorous, through the pylorus into the duodenum. The mucous lining of the intestines now manifests a decided degree of excitement, which being soon communicated to the gall bladder & pancreas, they speedily pour forth their respective secretions, with which the chyme becomes fully impregnated, by reason of the incessant peristaltic movements of the bowels — It is generally supposed that a kind of chemical combination here takes place between the chyme, the bile and the pancreatic juice, by means of which the chyme is seperated into two parts; one of which, is termed chyle, is speedily taken up by the lacteals, and the other, which is excrementitial matter, is in due time discharged per anum — Physiologists, who embraced the above hypothesis, differed greatly in their opinions, as regards the probable use of the bile & pancreatic fluid.

Some of the ancients supposed, that the bile acting like a kind of soap, produced a mixture of the fatty & watery parts of the food —

Boerhaave, on the contrary, believed it proved useful by diluting the acidity of the chyme, but this has been opposed by Pringle & others —

Later experimenters assert that the bile is separated into two distinct parts, one of which is decidedly alkaline & unites with the Chyle, whilst the other, which is very bitter and disagreeable to the taste, passes off along with the excrementitial matter with which it combines -

The part which the pancreatic fluid plays, has never been satisfactorily explained - Some have supposed it was acid, & precipitated the alkaly of the bile - Others, again, have conjectured that its chief use was to dilute the bile, & thus diminish its activity; but this to say the least of it is not at all probable.

Leaving these hypotheses, I may state, that although the above mentioned method of explaining the process of chylification was very generally, if not universally received, within some years past, many individuals, after mature reflection, have concluded that this theory is very far from being correct -

Numerous experiments made in Europe, and some in this country, by impartial spectators, prove that the very facts, on which this opinion is founded, have been misunderstood; and of course, the arguments by which it has been defended, are of little or no value -

Mr. Brodie, in some of his numerous experiments, placed a ligature around the ductus Choledochus in several young Cats, & states that the process of Chylification was entirely suspended - This would seem to be a strong argument in favor of the old supposition; but several very distinguished physiologists, among I may mention Messrs — Tiedeman & Gmelin, state that on repeating this experiment, they did not meet with the same result, and that Chylification did take place -

If the process of chylification were owing to a chemical action between the chyme, the bile, and the pancreatic juice, we should expect to discover occasionally the presence of Chyle in the stomach, (or intestines?) inasmuch as we know that these fluids are forced into its cavity; but there does not exist, so far at least as I am aware, a well attested instance of this ever having occurred in health -

Tiedemann & Gmelin state as the result of their numerous experiments on the subject, that Chyle does not exist in the intestines - Their opinions will be best understood by quoting their own words: "Les pretendus flocons de chyle" say they, "qu'on rencontre dans l'intestin grele, ne sont, d'après nos observations, que des flocons de mucus, que l'aliment a pris de la nourriture, se trouvent, ce dans

en un fluide blanc, par suite de l'absorption d'un liquide chyleux". Le canal intestinal ne peut pas contenir de chyle dans l'etat normal; le chyle est la portion du contenu liquide de l'intestin grêle qui absorbent les vaisseaux lymphatiques". Majendie ~~says~~ speaks of this having found in the intestines what he terms the "elements of chyle", or "chyle in an imperfect state"; but probably he fell into the mistake above alluded to.

If we carefully examine the expressions of many of those who suppose that they have detected the presence of chyle in the intestines, we shall find that they are rather vague and unsatisfactory, and instead of being declarations of positive facts they are rather mere suppositions, to which the writers have been led from their belief in this opinion, for the support of which this ~~point~~ assertion forms a most important point.

The circumstance of chyle not being a simple substance, but on the contrary of a compound nature, as we find on being removed from the body, "it soon begins to concrete, & finally seperates into two parts a dense white coagulum and a transparent colourless fluid", although when first procured, it is a white & opaque, ~~the~~ ~~[illegible]~~ resembling cream, would make the action of the bile & much more complicated, than we should at a first view suppose, and is think opposed to the old hypotheses.